NAT'L INST. OF STAND & TECH
A11106 059154
rence
NBS
PUBLICATIONS

NBSIR 86-3366

Center for Electronics and Electrical Engineering

A11102 490065

Technical Publication Announcements

Covering Center Programs, July to September 1985 with 1986 CEEE Events Calendar

April 1986

U.S. Department of Commerce
National Bureau of Standards
National Engineering Laboratory
Gaithersburg, Maryland 20899

QC
100
.U56
86-3366
1986

INTRODUCTION TO THE CEEE TECHNICAL PUBLICATION ANNOUNCEMENTS

This is the sixth issue of a quarterly publication providing information on the technical work of the National Bureau of Standards Center for Electronics and Electrical Engineering. This issue of the CEEE Technical Publication Announcements covers the third quarter of calendar year 1985.

Organization of Bulletin: This issue contains citations and abstracts for Center papers published in the quarter. Entries are arranged by technical topic as identified in the table of contents and alphabetically by first author within each topic. Following each abstract is the telephone number of the individual to contact for more information on the topic; unless otherwise noted, this person is the first author. This issue also includes a calendar of Center conferences and workshops now planned for calendar year 1986, an announcement of recently issued standard reference materials, and a list of sponsors of the work.

Center for Electronics and Electrical Engineering: Center programs provide national reference standards, measurement methods, supporting theory and data, and traceability to national standards.

The metrological products of these programs aid economic growth by promoting equity and efficiency in the marketplace, by removing metrological barriers to improved productivity and innovation, by increasing U.S. competitiveness in international markets through facilitation of compliance with international agreements, and by providing technical bases for the development of voluntary standards for domestic and international trade. These metrological products also aid in the development of rational regulatory policy and promote efficient functioning of technical programs of the Government.

The work of the Center is divided into two major programs: the Semiconductor Technology Program, carried out by the Semiconductor Electronics Division (formerly the Semiconductor Materials and the Processes and Semiconductor Devices and Circuits Divisions) in Gaithersburg, MD, and the Signals and Systems Metrology Program, carried out by the Electrosystems Division in Gaithersburg and the Electromagnetic Fields and Electromagnetic Technology Divisions in Boulder, CO. Key contacts in the Center are given on the back cover; readers are encouraged to contact any of these individuals for further information.

Center sponsors: The Center Programs are sponsored by the National Bureau of Standards and a number of other organizations, in both the Federal and private sectors; these are identified on page 17.

Note on Publication Lists: Guides to earlier as well as recent work are the publication lists covering the work of each division. These lists are revised and reissued on an approximately annual basis and are available from the originating division.

NBSIR 86-3366

NBS
RESEARCH INFORMATION
CENTER
QC
100
.U56
86-3366
1986

TABLE OF CONTENTS

INTRODUCTION . . . . . inside front cover

SEMICONDUCTOR TECHNOLOGY PROGRAM

Integrated Circuit Test Structures 2

Process and Device Modeling 2

Packaging 2

SIGNALS AND SYSTEMS METROLOGY PROGRAM

FAST SIGNAL ACQUISITION, PROCESSING, & TRANSMISSION 2

Waveform Metrology 2

Cryoelectronic Metrology 4

Antenna Metrology 5

Noise Metrology 6

Microwave Metrology 7

Optical Fiber Metrology 8

Other Fast Signal Topics 9

ELECTRICAL SYSTEMS 11

Power Systems Metrology 11

Superconductors 12

Magnetic Materials and Measurements 13

ELECTROMAGNETIC INTERFERENCE 13

1986 CEEE CALENDAR 15

RECENTLY ISSUED STANDARD REFERENCE MATERIALS 16

CEEE SPONSOR LIST 17

KEY CONTACTS IN CENTER, CENTER ORGANIZATION . . . . . back cover

SEMICONDUCTOR TECHNOLOGY PROGRAM

Integrated Circuit Test Structures

Yen, D., Glendinning, W. B., and Linholm, L. W., **An Electrical Test Structure for Proximity Effects Measurement and Correction**, J. Electrochem. Soc., Vol. 132, No. 7, pp. 1726-1729 (July 1985).

This paper describes the design of a test structure and electrical test method for estimating the magnitude of proximity effects in electron-beam lithography. The test structure consists of a van der Pauw cross resistor for measuring sheet resistance, a bridge resistor for measuring electrical linewidth, and a second bridge resistor simulating a close line-space environment for measuring electrical linewidth where proximity exposure effects from nearby patterns may be encountered. In this experiment, test structures were delineated in aluminum on silicon wafers using electron-beam exposure and wet chemical etching. Electrical measurements from these test structures are compared to optical measurements to verify the measurement method. In addition, results from the test structures are used to estimate the Gaussian parameters for the Gaussian model commonly used for proximity corrections.
[Contact: Loren W. Linholm (301) 921-3801]

Process and Device Modeling

Wilson, C.L., Roitman, P., and Blue, J.L., **High Accuracy Physical Modeling of Submicron MOSFETs**, IEEE Transactions on Electron Devices, Vol. ED-32, No. 7, pp. 1246-1258 (July 1985).

Using the data obtained from the measurements described in this work, it is possible to model the drain current for all of the transistors studied with no adjustable parameters. Transistors with 0.81-μm channel length differ in model input from those with 8.17-μm channel length only in the length of the polysilicon gate. The accuracy of the simulation is maintained over the subthreshold, triode, and saturation regions and is comparable for all channel lengths.
[Contact: (301) 921-3621]

Packaging

Oettinger, F.F., **Thermal Measurements of VLSI Packages - A Critical Overview**, in book, Abstracts of the IEEE/NBS VLSI Packaging Workshop, Gaithersburg, Maryland, September 9-11, 1985, pp. 26-29.

Techniques to thermally characterize ceramic and plastic VLSI packages are discussed. Computer simulations and both direct and indirect thermal evaluation techniques are highlighted. Limitations and strengths of the various techniques are identified.
[Contact: (301) 921-3541]

FAST SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

Waveform Metrology

Gans, W.L., **Picosecond Pulse Measurements at NBS**, Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 142-144.

The primary system used at NBS, Boulder to measure fast (picosecond to nanosecond regime), repetitive, electrical pulse parameters consists essentially of a wideband (dc-18 GHz) sampling oscilloscope interfaced to a minicomputer. This paper describes the techniques employed at NBS to reduce the effects of two major sources of pulse measurement error. These two sources are the distortions caused by the sampling head circuitry and by sample timing jitter. The techniques employed are based on the deconvolution methods of Tikhonov.
[Contact: (303) 497-3538]

Waveform Metrology, cont'd.

Kuffel, J., Malewski, R., van Heeswijk, R., and Lawton, R.A., **Dynamic Performance of Digital Recorders Used for Monitoring High Voltage Impulse Tests,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 211-215.

Frequency and time domain characteristics of digital transient recorders (in short, digitizers) are discussed in order to establish the requirements on digitizers used for high voltage testing. Results of an experimental study performed on a 200-MHz, 8-bit digitizer (Tektronix 7612D) are presented and related to the design features of this instrument. The inherent design characteristics and their influence on the digitizer dynamic performance are analyzed in view of simulation of the digitizer through a computer model.
[Contact: Robert A. Lawton (303) 497-3339]

Larsen, N.T., Vecchia, D.F., and Sugar, G.R., **VOR Calibration Services,** NBS Technical Note 1069 (April 1985).

The National Bureau of Standards has designed, constructed, and evaluated a standard for the support of very-high-frequency omnidirectional range (VOR) air navigation aids. The standard consists of two instruments: (1) a digital waveform signal generator for the composite VOR audio waveform, and (2) a standard phasemeter based on time series analysis of this waveform. Experimental results, a statistical analysis of them, and the listings of principal software are included.
[Contact: (303) 497-3711]

Lawton, R.A., **Pulse Waveform Standards for Electro-Optics,** Picosecond Electronics and Optoelectronics, Proceedings of the Topical Meeting, Lake Tahoe, Nevada, March 13-15, 1985, G.A. Mourou, D.M. Bloom and C.-H. Lee, Eds., (Springer-Verlag, Berlin), pp. 205-206.

This paper describes the development of reference waveform generators for transfer of NBS pulse measurement accuracy to an emerging class of electro-optic samplers having picosecond and subpicosecond time-resolution capabilities. A comb generator appears to be a promising candidate: it is commercially available and physically compact, it exhibits good signal-to-noise ratio, and the waveform duration covering the most significant parts of the waveform is commensurate with one scan of the sampler used.
[Contact: (303) 497-3339]

Lawton, R.A., **Status Report: Transient Waveform Recorder Standard,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 154-155.

The origin and activities of the Waveform Measurement and Analysis Technical Committee of the Instrumentation and Measurement Society of the IEEE are described. Responding to the recent availability of several digital waveform recorders, the committee is developing a performance standard for waveform recorders. The participants on the committee are identified, and the current state of development of a draft standard is given.
[Contact: (303) 497-3339]

Leedy, T.F., and Bell, B.A., **Automatic Test Equipment Calibration/Performance Verification Evaluation and Research Program (JLC/DoD Subtask 30702),** NBSIR 84-2978 (December 1984).

This work describes an experimental approach to verify the performance of selected third-generation automatic test systems. As part of an ongoing project, this work builds on previous research in methods to characterize the accuracy of test systems measuring ac and dc voltages. This report describes the methods used to characterize an ac voltage

Waveform Metrology, cont'd.

source covering a voltage range of approximately 225 mV to 2.8 V rms over a frequency range of 50 kHz to 10 MHz. In addition, the characterization of a precision phase angle generator, designed and built at NBS, is described. Finally, the measurement results obtained with an automatic test system, using a new software operating system and the ac, dc, and phase angle transport standards, are discussed in detail.
[Contact: (301) 921-2727]

Cryoelectronic Metrology

Hamilton, C.A., Lloyd, F.L., and Kautz, R.L., **Superconducting A/D Converter Using Latching Comparators**, IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 197-199 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

This paper describes the design and performance of a six-bit analog-to-digital (A/D) converter using fast edge latching comparators. Simulations predicting conversion times of 100 ps and 100-MHz signal bandwidth are verified experimentally. The addition of a superconducting track/hold circuit in front of the A/D converter is expected to substantially improve the signal bandwidth.
[Contact: (303) 497-3740]

Kautz, R.L., **Chaos and Thermal Noise in the RF-Biased Josephson Junction**, J. Applied Physics, Vol. 58, No. 1, pp. 424-440 (1 July 1985).

The effect of thermal noise on chaotic behavior in the rf-biased Josephson junction is studied through digital simulations. In instances for which chaotic behavior occurs in the noise-free system, it is found that the dynamics of the system are almost unchanged by the addition of thermal noise unless the level of thermal noise exceeds that of the chaotic state. In instances for which the only stable states of the noise-free system are periodic solutions, small amounts of thermal noise can induce the junction to hop between two different dynamical states, producing a low-frequency noise level much higher than that of the thermal noise. Such noise-induced hopping can occur either between two periodic solutions or between a periodic solution and a metastable chaotic solution. When a metastable chaotic state is involved, temperatures somewhat higher than those which produce hopping can destabilize the periodic solution to the point where the system spends virtually all of its time in the metastable chaotic state, creating noise-induced chaos. The similarities between chaotic behavior at zero temperature and noise-induced chaos are sufficiently strong that it may be difficult to distinguish the two cases experimentally.
[Contact: (303) 497-3391]

McDonald, D.G., and Frederick, N.V., **Amplification by a Voltage Locked Array of Josephson Junctions**, Applied Physics Letters, Vol. 47, No. 5, pp. 530-532 (1 September 1985).

We have studied a new type of Josephson junction amplifier which is based on a two-junction array; the junctions are mutually phase locked at the Josephson self-oscillation frequency. With this frequency at 82 GHz, the voltages of the junctions remain equal (locked) for a bias current range as large as 60% of the critical current. Over a much smaller bias range, with an applied signal frequency of 1 kHz, a small-signal power gain of 19 dB was measured, accompanied by a negative resistance input impedance. This performance is consistent with a quasi-static theory of the amplifier.
[Contact: (303) 497-5113]

McGrath, W.R., Raisanen, A.V., Richards, P.L., Harris, R.E., and Lloyd, F.L.,

Cryoelectronic Metrology, cont'd.

Accurate Noise Measurements of Superconducting Quasiparticle Array Mixers, IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 212-215 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

We have constructed a 30- to 40-GHz test apparatus which allows us to measure the noise temperatures of superconductor-insulator-superconductor (SIS) mixers with an accuracy of better than ±1 K. This is a factor of six improvement over earlier measurements. The most accurate measurement made thus far of a mixer which uses a single Pb-alloy junction yielded T_M = 9.2 ± 0.9 K; and mixer gain: C_M = 0.240 ± 0.005. In addition, SIS mixers employing arrays of N = 1, 5, 10, 25, and 50 tunnel junctions in series have been tested. The input power required to saturate the array mixers was found to increase as N^2 and the gain and noise temperatures of the array mixers were independent of N.
[Contact: Richard E. Harris (303) 497-3776]

Muhlfelder, B., Beall, J.A., Cromar, M.W., Ono, R.H., and Johnson, W.W., **Well Coupled, Low Noise, dc SQUIDS,** IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 427-429 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

We have designed, fabricated, and tested a Double Transformer (DT) coupled dc SQUID (Superconducting Quantum Interference Device) with low noise, an input inductance of 1 μH, and a smooth input-output characteristic. A transmission line model is presented to explain a resonance in the input-output characteristic of early versions of this device. Guided by the results of numerical simulations, a new version of this device results are presented that show that the resonance can be moved to a higher voltage by reducing the area of the SQUID loop. The voltage-external flux characteristic of some of these new devices agrees to within 10% with computer simulations. The minimum detectable energy per unit bandwidth (MDE) referred to the SQUID loop is 10 h, where h is Planck's constant. Computer simulations indicate an MDE of 6 h.
[Contact: (303) 497-3597]

Ono, R.H., Beall, J.A., and Harris, R.E., **Fabrication of a Miniaturized DCL OR Gate,** IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 846-849 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

Using niobium edge junctions and electron-beam lithography (EBL), we have made direct-coupled-logic (DCL) OR gates with 1-μm minimum linewidths. The gate cell, containing an isolator and a buffer section, fits into an area of approximately 25 by 30 μm^2.

Our computer simulations show that these gates can have switching times of less than 10 ps. We have simulated the DCL circuit with several values of the most space-consuming element, an inductor. This paper describes the results of these simulations and presents a detailed description of the 7-level fabrication process. The mix of optical and electron-beam lithography used relies heavily on an inexpensive, yet powerful, circuit layout program.
[Contact: (303) 497-3762]

Antenna Metrology

Hill, D.A., **Out-of-Band Response of Reflector Antennas,** NBSIR 85-3021 (April 1985).

The response of reflector antennas to out-of-band frequencies has been analyzed using physical optics. A simple approximate expression has been obtained for the effective aperture, and this

Antenna Metrology, cont'd.

expression yields both the receiving pattern and the frequency dependence on the on-axis gain. The theory has been compared with published out-of-band measurements, and the pattern agreement is good, but the measured gain falls below the theory. This discrepancy is caused by mismatch loss in the coax-to-waveguide adapter.
[Contact: (303) 497-3472]

Hill, D.A., and Koepke, G.H., **A Near-Field Array of Yagi-Uda Antennas for Electromagnetic Susceptibility Testing,** NBS Technical Note 1082 (July 1985).

In electromagnetic susceptibility testing of electronic equipment, the ideal incident field is a plane wave. To approximate this condition, a seven-element array of Yagi-Uda antennas has been constructed and tested at a frequency of 500 MHz. The element weightings are determined by a near-field synthesis technique which optimizes the uniformity of the field throughout a rectangular test volume in the near field of the array. The amplitude and phase of the electric field have been measured throughout the test volume with a short dipole probe, and the agreement with the theory is excellent.
[Contact: (303) 497-3472]

Muth, L.A., **A Theory of Mutual Impedances and Multiple Reflections in an N-Element Array Environment,** NBS Technical Note 1078 (February 1985).

A general theoretical approach is formulated to describe the complex electromagnetic environment of an N-element array. The theory reveals the element-to-element interactions and multiple reflections within the array. From the formulation, it is found that the interaction between an excited element and an open-circuited element can be viewed as the sum of terms describing all possible signal paths within the array environment which start from the radiating element and terminate on the element under observation. Within all paths except the most direct one, multiple reflections between subgroups of elements take place. The resulting solution is highly structured and recursive and is discussed in detail in the text. Illustrative examples are provided to facilitate understanding of these ideas.
[Contact: (303) 497-3603]

Wyss, J.C., and Sheeran, S.T., **A Practical Optical Modulator and Link for Antennas,** J. Lightwave Technology, Vol. LT-3, No. 2, pp. 316-321 (April 1985).

This paper describes a practical application of a technique for coupling an antenna to a receiver using a passive fiber-optic link. This technique should avoid pickup and electromagnetic perturbations normally associated with the use of electrically conductive cables. Laser light (632.8 nm) is modulated at the antenna by an electrooptic lithium-tantalate crystal and is then transmitted with a fiber-optic cable to the receiver electronics. Using an avalanche photodiode, the amplitude-modulated optical signal is converted to an electrical signal. The crystal is mounted directly on an antenna without amplifiers or other electrically powered components. Using a broad-band antenna with fields generated in an anechoic chamber and a standard TEM cell, the frequency response as measured dropped 3 dB per 1.0 GHz from 100 MHz to at least 2.0 GHz, with a signal-to-noise ratio of 5 dB with a 1.0-V/m field and a 1.0-kHz bandwidth. A dynamic range of at least 60 dB is shown.
[Contact: Charles K. S. Miller (303) 497-3131]

Noise Metrology

Daywitt, W.C., **A Derivation for the Noise Temperature of a Horn-Type Noise Standard,** Metrologia, Vol. 21, pp.

Noise Metrology, cont'd.

127-133 (1985) [previously published as Appendix A, NBS Technical Note 1071, December 1983].

Noise sources consisting of an electromagnetic horn aimed at an absorbing material have been in use for many years. A satisfactory derivation of the noise temperature for such a configuration has been missing, however, preventing the use of this horn-type noise source as a primary reference standard. The derivation described in this paper models the various noise emitters within the source well enough to provide an accurate estimate of the noise temperature and a complete error analysis.
[Contact: (303) 497-3720]

Daywitt, W.C., **Broadband Noise Source Applications,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 165-166.

Accurate noise characterization of amplifiers and communication systems requires the use of thermal noise standards. This note is a brief review of the use of such standards as a basis for the measurement of effective input noise temperature and the G/T of a satellite earth terminal receiving system.
[Contact: (303) 497-3720]

Perera, S., **Noise Temperature Measurements at the National Bureau of Standards,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 159-160.

Thermal noise presents the ultimate limitation in the reception and detection of low-level electromagnetic signals. This paper briefly reviews the physics of thermal noise, devices that generate noise, and measurement methods to characterize noise sources.
[Contact: (303) 497-3546]

Reeve, G.R., and Miller, C.K.S., **Current NBS Metrology Capabilities and Limitations at Millimeter Wave Frequencies,** Proceedings of the 1985 Measurement Science Conference, Santa Clara, California, January 17-18, 1985, pp. 296-314.

The National Bureau of Standards (NBS) establishes national artifact standards and provides a metrology base for U.S. industry and technology. In the millimeter wave frequency spectrum, NBS has not established all of the required metrology to meet the needs of industry or government for this technology. It is the intent of this paper to describe the technical demands of responding to the challenges of millimeter-wave technology. A description of the current capabilities that exist at NBS is given for those parameters and frequencies where measurement services exist. Where novel standards have been developed, such as the 94-GHz thermal noise standard, the physical basis for the standard is described to indicate the changes from lower frequency designs and the challenges that had to be overcome. Limitations in services and in concepts of standards for providing those services are described to indicate the degree of research that must be undertaken to satisfy future industrial needs in this evolving technology.
[Contact: (303) 497-3557]

Microwave Metrology

Holt, D.R., and Hoer, C.A., **Estimation of True Power Ratios in Six-Port Network Analyzers Using Diode Detectors,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 140-141.

A model for detector nonlinearity is included in the determination of six-port parameters without using additional standards. A computer simulation was performed assuming that the true power

Microwave Metrology, cont'd.

into each six-port detector is related to the power observed by the detector. Simultaneous estimation of the six-port and detector parameters is accomplished through a nonlinear least-squares algorithm. Results of the simulation compare the reflection coefficient Γ computed from corrected power readings and Γ calculated from observed power readings.
[Contact: (303) 497-3574]

Juroshek, J.R., and Hoer, C.A., **A Technique for Extending the Dynamic Range of the Dual Six-Port Network Analyzer,** IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-33, No. 6, pp. 453-459 (June 1985).

The dynamic range of the six-port type of automatic network analyzer is typically limited to measuring two-port devices with a transmission coefficient S_{12} in the range of 0 to -60 dB. This paper describes a subcarrier approach for extending the dynamic range of the dual six-port network analyzer. The subcarrier is generated by inserting a 10-kHz, biphase modulator ahead of one of the six ports. With the subcarrier approach, measurements of S_{12} in the range of -60 to -100 dB can be made. Test results are presented showing measurements of S_{12} = -80 dB with a precision of ±0.05 dB or better, and an accuracy of ±0.16 dB or better at 3 GHz. Measurement results are also presented showing the dynamic range achievable with thermistor and barretter detectors.
[Contact: (303) 497-5362]

Kanda, M., and Orr, R.D., **A Radio-Frequency Power Delivery System: Procedures for Error Analysis and Self-Calibration,** NBS Technical Note 1083 (August 1985).

An expression is developed for net power delivered to a load in terms of the indicated forward and reflected power and the system S-parameters and reflection coefficients. The directional coupler is treated as nonideal with power reflections assumed between all ports. The system itself is used to evaluate the major S-parameter terms in net power computation, and uncertainty in the computer power is derived from origins in the power meter readings and incompletely known S-parameters.
[Contact: (303) 497-5320]

Reeve, G.R., and Miller, C.K.S., **Current NBS Metrology Capabilities and Limitations at Millimeter Wave Frequencies,** Proceedings of the 1985 Measurement Science Conference, Santa Clara, California, January 17-18, 1985, pp. 296-314.

The National Bureau of Standards (NBS) establishes national artifact standards and provides a metrology base for U.S. industry and technology. In the millimeter wave frequency spectrum, NBS has not established all of the required metrology to meet the needs of industry or government for this technology. It is the intent of this paper to describe the technical demands of responding to the challenges of millimeter-wave technology. A description of the current capabilities that exist at NBS is given for those parameters and frequencies where measurement services exist. Where novel standards have been developed, such as the 94-GHz thermal noise standard, the physical basis for the standard is described to indicate the changes from lower frequency designs and the challenges that had to be overcome. Limitations in services and in concepts of standards for providing those services are described to indicate the degree of research that must be undertaken to satisfy future industrial needs in this evolving technology.
[Contact: (303) 497-3557]

Optical Fiber Metrology

Rodhe, P.M., **Intramodal Part of the Transfer Function for an Optical Fiber,**

Optical Fiber Metrology, cont'd.

J. Lightwave Technology, Vol. LT-13, No. 1, pp. 154-158 (February 1985).

Intramodal contributions in measurements of optical fiber bandwidth are investigated theoretically and experimentally in the quasimonochromatic case. A relation is established between the intramodal transfer function and a possibly non-Gaussian source spectrum, which may also vary with modulation frequency. By considering the latter variation in particular, we are able to predict the intramodal length dependence and show how it may deviate from that of a conventional approach.
[Contact: Aaron A. Sanders (303) 497-5341]

Other Fast Signal Topics

Katzir, Y., Young, M., and Glaser, I., **Pattern Recognition Using Incoherent OTF Synthesis and Edge Enhancement,** Applied Optics, Vol. 24, No. 6, pp. 863-867 (15 March 1985).

This paper describes a system for pattern recognition using an incoherent-optical correlator. The system uses optical transfer function synthesis to perform correlations with an edge-enhanced image of the object or pattern being sought. The resulting correlations are free of bias and show good discrimination between objects. In addition, the difficult or time-consuming computations are performed before the operation of the system; this reduces the amount of postprocessing by computer and should allow real-time operation at video rates.
[Contact: Matt Young (303) 497-3223]

Kline, K.E., and DeWeese, M.E., **Metrology for Electromagnetic Technology: A Bibliography of NBS Publications,** NBSIR 85-3029 (July 1985).

This bibliography lists the publications of the personnel of the Electromagnetic Technology Division of NBS in the period from January 1970 through December 1984. A few earlier references that are directly related to the present work of the Division are included.
[Contact: (303) 497-3678]

Major, J.R., Livingston, E.M., and Adair, R.T., **Automatic Frequency Response of Frequency-Modulated Generators Using the Bessel Null Method,** 24th ARFTG Conference Digest, Fall 1984, Columbia, MD, December 5-6, 1984, pp. 131-153 (1985). [An identical invited paper will be published in the Proceedings of the Test and Measurement World Expo, San Jose, California, May 13-15, 1985.]

This paper describes a Bessel null technique to measure the frequency response of a frequency-modulated rf carrier and a program to automate frequency response measurements of signal generators with output frequencies from 0.450 to 2000 MHz. The measurements obtained using this technique are more accurate than those obtained by a highly trained technician using a manual system.

Automated measurement of this process is desirable since the manual method is subject to the following problems: (1) excessive time, (2) error in finding the null, and (3) lack of assurance that the null is the first Bessel null. Automated measurements can be performed using a system controller, a spectrum analyzer, a function generator, and a voltmeter (all of which are compatible and controllable remotely).

The nonlinear relationship between modulating signal amplitude and the center frequency amplitude of the carrier is a major obstacle to automated measurement. This problem was solved by obtaining an approximate formula for this nonlinear curve.

Assurance that the null found is the

Other Fast Signal Topics, cont'd.

first Bessel null is provided by the analysis of the frequency response of the signal generator under test as displayed on the spectrum analyzer. [Contact: (303) 497-3149]

Reeve, G.R., and Miller, C.K.S., **Current NBS Metrology Capabilities and Limitations at Millimeter Wave Frequencies**, Proceedings of the 1985 Measurement Science Conference, Santa Clara, California, January 17-18, 1985, pp. 296-314.

The National Bureau of Standards (NBS) establishes national artifact standards and provides a metrology base for U.S. industry and technology. In the millimeter wave frequency spectrum, NBS has not established all of the required metrology to meet the needs of industry or government for this technology. It is the intent of this paper to describe the technical demands of responding to the challenges of millimeter-wave technology. A description of the current capabilities that exist at NBS is given for those parameters and frequencies where measurement services exist. Where novel standards have been developed, such as the 94-GHz thermal noise standard, the physical basis for the standard is described to indicate the changes from lower frequency designs and the challenges that had to be overcome. Limitations in services and in concepts of standards for providing those services are described to indicate the degree of research that must be undertaken to satisfy future industrial needs in this evolving technology. [Contact: (303) 497-3557]

Young, M., and Johnson, E.G., Jr., **Redefining the Scratch Standards**, NBS Technical Note 1080 (February 1985). [Some of this material was presented in a paper, Tunable Scratch Standards, given at the conference of the International Society for Optical Engineering, Measurement and Effects of Surface Defects and Quality of Polish, Los Angeles, CA, January 21-22, 1985, and published in Proc. SPIE, Vol. 525, pp. 70-77, SPIE, P.O. Box 20, Bellingham, WA 98227 (1985).]

The scratch standard (MIL-O-13830A) is a cosmetic standard that is effected by a visual comparison with a set of submasters that are in turn evaluated by comparison with a set of master standards. Both manufacture and certification of the submasters are somewhat unreliable. In this paper, we show that the submasters can be classified according to the relative power scattered at a relatively small angle. We have designed etched gratings with which to replace the submasters; these gratings have the appearance of scratches but diffract light into a broad peak between 5 and 10 degrees off the axis of the incident beam. We have classified some prototypes both by comparison with the master standards and by a photoelectric measurement; agreement between the two methods is good. We suggest that such gratings be used as the submasters and possibly that they be classified by a photoelectric, rather than visual, measurement. [Contact: (303) 497-3223]

Young, M., **Scratch Standards Should Not Be Used to Predict Damage Threshold** in Laser Induced Damage in Optical Materials: 1982, Proceedings of a Symposium, H.E. Bennett, A.H. Guenther, D. Milam, and B.E. Newman, Eds., NBS Special Publication 669 (January 1984).

The scratch and dig standards are the most widely used surface quality standards in the industry. In the Proceedings of the 1980 Symposium, H. Bennett showed theoretically that damage ought to be initiated near a defect and related damage threshold to defect size. Evidently, because of one or both of these considerations, some purchasers may use the scratch standards to specify the surface quality of components intended for high power laser systems.

Other Fast Signal Topics, cont'd.

Although damage is often associated with the presence of a defect, this is an inappropriate use of these purely cosmetic standards; the classification of a particular scratch correlates only very loosely with its width or depth. Even if a component is made of glass, little or nothing pertinent to damage threshold may be determined by classifying a scratch according to the cosmetic standard.
[Contact: (303) 497-3223]

Young, M., **The Scratch Standard Is Not a Performance Standard**, Proceedings of the Optical Fabrication and Testing Workshop, Cherry Hill, New Jersey, June 12-13, 1985, pp. ThAA4-1 and 2.

A history and description of the scratch standard is presented, showing that the scratch number should never be related to its width and that the standard is cosmetic only.
[Contact: (303) 497-3223]

ELECTRICAL SYSTEMS

Power Systems Metrology

Misakian, M., **High Voltage Divider and Resistor Calibrations,** NBS Technical Note 1215 (July 1985).

An NBS calibration service for determining the ratio of high voltage dc dividers and the resistance of high voltage resistors is described. Calibrations are performed with a Wheatstone bridge apparatus with a simple guard system. Sources of systematic error are identified and methods for characterizing the NBS standard high voltage resistors are discussed. Ratio and resistance values can be determined between the voltages of 10 kV and 150 kV with an uncertainty of less than ±0.01%.
[Contact: (301) 921-3121]

Petersons, O., and Mehta, S.P., **Calibration of Test Systems for Measuring Power Losses of Transformers,** NBS Technical Note 1204 (August 1985).

A calibration system for accuracy verification and alignment of test systems for measuring transformer losses is described. Methodologies are presented for assessing measurement uncertainties and for evaluating overall accuracy of test systems. Procedures are suggested for continuing maintenance and calibration of standard instruments and test systems to ensure traceable measurements.
[Contact: (301) 921-2328]

Ramboz, J.D., and Petersons, O., **Emerging New Requirements for Electric Power and Energy Measurements**, Proceedings of the 1985 Workshop and Symposium of the National Conference of Standards Laboratories, Boulder, Colorado, July 15-18, 1985, pp. 3-12.

Advances in electronic instrumentation technology have brought greater stability and precision to transducers that are utilized for measuring electric power and energy. An advantage of instruments based on electronic transducers is that they can be readily adapted to the measurement of other quantities such as current, voltage, reactive and apparent power, power factor, demand, time-of-day readings, etc. The increases in the cost of energy during the past decade have stimulated the acceptance of new instrument technology by the users associated with the electric power industry. The electronic instruments have especially found acceptance in metering installations for large loads and at interchange points between utilities. Modern instruments, because of their accuracy capabilities, are also advantageous in those applications where the efficiency of large equipment such as generators and transformers has to be measured. A large number of instruments used as physical standards by the industry and submitted recently to the National Bureau of Stan-

Power Systems Metrology, cont'd.

dards (NBS) for calibration have been of the electronic type. The calibration accuracies requested from NBS for power and energy measurements have increased at least fivefold (uncertainty reduction from ±0.05% to ±0.01%) within the past several years. Calibrations for different quantities and values are being requested. These changing calibration requirements and the response of NBS to meet the requests of its calibration clientele are discussed.
[Contact: (301) 921-3121]

Schwitz, W., Kampfer, R., Braun, A., Souders, T.M., Moore, W.J.M., Cassidy, B.R., and Deacon, T.A., **International Comparison of Current Transformer Calibrations**, IEEE Transactions on Instrumentation and Measurement, Vol. IM-34, No. 2, pp. 234-238 (June 1985).

An international comparison of current transformer calibrations among five metrology laboratories has been conducted. The measurements were made at current ratios ranging from 1 A:1 A to 200 A:1 A at 10, 100, and 200 percent of rated current and from 5 A:5 A to 200 A:5 A at 1, 10, 100, and 200 percent of rated current, at a frequency of 50 Hz. Several ratios have also been compared at 60 Hz.
[Contact: T. Michael Souders (301) 921-2727]

Siddagangappa, M.C., and Van Brunt, R.J., **Decomposition Products from Corona in SF_6/N_2 and SF_6/O_2 Mixtures**, Proceedings of the Eighth International Conference on Gas Discharges and Their Applications, Oxford, England, September 16-20, 1985, pp. 247-250.

Absolute concentrations of SOF_4, SOF_2, SO_2F_2, SO_2, NO, N_2O, and H_2O produced from continuous, dc, point-plane negative corona at a current of 40 A were measured in SF_6/N_2 and SF_6/O_2 mixtures containing trace amounts of H_2O and 1 to 95% N_2 or 1 to 10% O_2 for a total gas pressure of 200 kPa (~2 atm). The absolute and SF_6-normalized charge rates-of-production for these by-products have been determined as a function of N_2 or O_2 content. The results are interpreted in terms of a model for electric-discharge-induced decomposition of SF_6 discussed previously by Van Brunt. The presence of N_2 accelerates the rate of SF_6 decomposition by inhibiting the recombination of SF_6 dissociation products. At levels up to 10%, O_2 actually lowers the rates of oxyfluoride and SO_2 production due to its effect in reducing the mean energy of electrons in the discharge and thus the dissociation rate of SF_6.
[Contact: Richard J. Van Brunt (301) 921-3121]

Superconductors

Ekin, J.W., Yamashita, T., and Hamasaki, K., **Effect of Uniaxial Strain on the Critical Current and Critical Field of Chevrel Phase $PbMo_6S_8$ Superconductors**, IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 474-477 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

The first measurements of the effect of uniaxial strain on the critical current of a Chevrel-phase superconductor, $PbMo_6S_8$, have been obtained at 4.2 K in magnetic fields from 2 T to 24 T. The data show there is a very significant reversible effect of elastic strain on the critical current of $PbMo_6S_8$, comparable in magnitude to that observed in Nb_3Sn. This is because both the peak pinning force and upper critical field are very sensitive to elastic strain. A correlation is noted between the elastic strain effect, radiation sensitivity, and crystal phase.
[Contact: (303) 497-5448]

Hong, M., Maher, D.M., Ellington, M.B., Hellman, F., Geballe, T.H., Ekin, J.W., and Holthuis, J.T., **Further Investigations of the Solid-Liquid Reaction**

Superconductors, cont'd.

and High-Field Critical Current Density in Liquid-Infiltrated Nb-Sn Superconductors, IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 771-774 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

Superior superconducting properties, such as high critical current density (J_c) and transition temperature (T_c), have been obtained from reacted liquid-infiltrated Nb-Sn composite wires. These excellent properties are attributed to the chemistry and structure of the material which is prepared by a unique solid (Nb)-liquid (Sn) reaction. From heat capacity measurements, sharp bulk superconducting transitions of the A15 phase occur at 17.2-18 K and the weight fraction of A15 in the composite wire is ~23%. Analytical electron microscopy techniques have shown that: the microstructure of these conductors consists of alternating large- grain and small-grain filaments; these two types of filaments correspond to BCC Nb(Sn) and cubic A15 $Nb_{75\pm x}Sn_{25\mp x}$ phases, respectively; the A15 filaments ($\leq$0.5 μm) are chemically homogeneous in terms of measured x-ray intensity ratios to within ±7% which implies that x ~ 1.5; and the A15 grains are essentially free of extended lattice disorder down to a resolution of ~0.34 nm.

Recent work in which Nb is alloyed with Ta has shown that these superconducting properties can be improved upon; e.g., high overall J_c's of ~1.8×10^4 A/cm^2 at 20 T and 4.2 K have been measured. Also, the liquid-infiltrated Nb(Ta)-Sn composites have a damage strain tolerance nearly double that of commercial bronze-processed Nb-Sn conductors.
[Contact: John W. Ekin (303) 497-5448]

Magnetic Materials and Measurements

Cromar, M.W., Clark, A.F., and Fickett, F.R., **The NBS Magnetic Monopole Detector**, IEEE Transactions on Magnetics, Vol. MAG-21, No. 2, pp. 418-420 (March 1985). [Proceedings of Applied Superconductivity Conference, San Diego, California, September 9-13, 1984]

We have built and operated several inductive type monopole detectors, the present one having three concentric, orthogonal loops operated in coincidence. The area of each loop is 200 cm^2, and the cross-sectional area of the superconducting shield is 700 cm^2. The detector loops are in a trapped magnetic field of approximately 3 milligauss. The system is mechanically stable and is relatively insensitive to external disturbances, both mechanical and electromagnetic. The detector is quiet, having a signal-to-noise ratio for monopole detection of approximately 20. We have also investigated several sources of noise and spurious signals which might mimic a monopole event.
[Contact: (303) 497-5375]

ELECTROMAGNETIC INTERFERENCE

Bensema, W.D., Reeve, G., and Koepke, G.F., **A Multisensor Automated EM Field Measurement System,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 200-202.

A system is being developed to monitor and collect electromagnetic (EM) field strength at multiple locations simultaneously. The system has two modes of operation: (1) for sampling EM fields that are stationary for times of the order of 200 ms, and (2) for sampling changing EM fields with a system resolution of 10 μs. Sensing elements for Mode 1 consist of three electrically short orthogonal dipoles mounted together, single dipole elements, or small loop antennas. Each element feeds a separate data input channel for a maximum of 30 channels. Rf energy is converted to dc by a small diode detector

Electromagnetic Interference, cont'd.

at each dipole. Several sets of 30 sensing elements each are planned to cover specific measurement regions of amplitude (1 V/m or greater) and frequency (100 MHz-18 GHz). Mode 2 sensors are diode detectors driven by broadband antennas. System computer data processing proceeds in real time and includes calculation of field strength based on probe calibrations and processing of resultant data to satisfy measurement goals.
[Contact: (303) 497-3465]

Cruz, J.E., and Larsen, E.B., **Screenroom Measurements of Antenna Factors,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, p. 208.

The measurement of electromagnetic fields in a shielded enclosure (screenroom) has serious problems because of uncertain antenna factors and multipath reflections from conductive surfaces. Most electromagnetic interference antennas at NBS are calibrated in a known field at an open-field site using the standard antenna method. Because these antenna factors are not necessarily applicable for making measurements in a screenroom, the measurement errors are difficult to determine. This paper presents the results for antenna factors determined in a screenroom using the two-antenna method. These antenna factors are compared with antenna factors determined at an open-field site and in an anechoic chamber. Experiment data are presented to show the variability of antenna factor as a function of frequency and location in the screenroom, thereby providing an indication of error bounds.
[Contact: (303) 497-3763]

Hill, D.A., and Koepke, G.H., **A Near-Field Array of Yagi-Uda Antennas for Electromagnetic Susceptibility Testing,** NBS Technical Note 1082 (July 1985).

In electromagnetic susceptibility testing of electronic equipment, the ideal incident field is a plane wave. To approximate this condition, a seven-element array of Yagi-Uda antennas has been constructed and tested at a frequency of 500 MHz. The element weightings are determined by a near-field synthesis technique which optimizes the uniformity of the field throughout a rectangular test volume in the near field of the array. The amplitude and phase of the electric field has been measured throughout the test volume with a short dipole probe, and the agreement with the theory is excellent.
[Contact: (303) 497-3472]

Kanda, M., and Nahman, N.S., **Standards for Measurement of Electromagnetic Fields,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, pp. 20-23.

The standards developed at NBS for measurements of electromagnetic fields are reviewed along with the industrial applications that engendered their development. Some attention is given to future measurement requirements and the NBS programs to meet them.
[Contact: (303) 497-5320]

Kanda, M., Randa, J., and Nahman, N.S., **Possible Estimation Methodologies for Electromagnetic Field Distributions in Complex Environments,** NBS Technical Note 1081 (March 1985).

The problem of measuring and characterizing complicated multiple-source, multiple-frequency electromagnetic environments is becoming more important and more difficult as electrical devices proliferate. This paper outlines three general approaches to the problem which are currently under investigation at the National Bureau of Standards. The three approaches are: (1) a statistical treatment of the spatial distribution of

Electromagnetic Interference, cont'd.

electromagnetic field intensities, (2) a numerical computation using a finite-difference (or lattice) form of the electromagnetic action functional, and (3) use of a directional probe to scan a volume. All three methods are still in the development stage, but each appears promising.
[Contact: (303) 497-5320]

Larsen, E.B., and Cruz, J.E., **E and H Fields in Transmission Lines and Coils for Susceptibility Testing, Probe Calibration, and RF Exposure Chambers,** Proceedings of the IEEE Instrumentation and Measurement Technology Conference, Tampa, Florida, March 20-22, 1985, p. 199.

This paper deals with the instrumentation and design equations for several systems used to generate calculable electric (E) and magnetic (H) fields for electromagnetic compatibility (EMC) testing. These "standard" electromagnetic (EM) fields with known magnitude are used to: (a) test the susceptibility of electronic equipment to radiated fields, (b) calibrate E and H field probes for measuring and mapping fields, and (c) expose biological specimens in a known EM environment. The design and use of so-called transverse electromagnetic (TEM) cells terminated in their characteristic impedance are described elsewhere.
[Contact: (303) 497-3540]

Ma, M.T., Kanda, M., Crawford, M.L., and Larsen, E.B., **A Review of Electromagnetic Compatibility/Interference Measurement Methodologies,** Proceedings of the IEEE, Vol. 73, No. 3, pp. 388-411 (March 1985).

This paper presents a review summary of radiated emission and susceptibility measurement methodologies currently used for assessing the electromagnetic compatibility/interference (EMC/EMI) characteristics of electronic devices and systems. In particular, measurement methods using open sites, transverse electromagnetic (TEM) cells, reverberating chambers, and anechoic chambers are discussed, in the light of their technical justifications and bases, their strengths and limitations, and interpretation of the measurement results.
[Contact: (303) 497-3800]

Wilson, P.F., and Ma, M.T., **Shielding-Effectiveness Measurements with a Dual TEM Cell,** IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-27, No. 3, pp. 137-142 (August 1985).

Small-aperture theory is used to investigate the dual transverse electromagnetic (TEM) cell. Analyzing coupling through an empty aperture versus a loaded aperture leads to a simple model of dual-TEM-cell material shielding-effectiveness (SE) measurements. Experimental data are compared to theory with good agreement in the case of an empty aperture. Some of the difficulties in analyzing a loaded aperture are discussed.
[Contact: (303) 497-3842]

1986 CEEE Calendar

22-23 April (Gaithersburg, MD)

Workshop on Test Procedures for Precision Instrumentation and ATE Systems. This Workshop is intended to provide a forum for the exchange of information among researchers, users, manufacturers, testing companies, and calibration laboratories on the procedures used in testing the performance of precision instrumentation and automatic test equipment systems. Technical topics planned include first-article and acceptance testing, bid-sample testing, maintenance and calibration testing, developing and writing specifications and procedures, "minimum-use" specifications, test accuracy ratios, economic tradeoffs of testing, case histories of specific test programs, optimum calibra-

1986 CEEE Calendar, cont'd.

tion strategies, and recommended practices. The Workshop proceedings will be published by the Institute of Electrical and Electronics Engineers.
[Contact: John R. Sorrells, (301) 921-2727]

23-27 June (Gaithersburg, MD)

1986 CPEM (Conference on Precision Electromagnetic Measurements). CPEM 86 is being sponsored by the U.S. National Bureau of Standards, the IEEE Instrumentation and Measurement Society, and the Union Radio Scientifique Internationale. The Conference will present papers covering the theory, design, performance, simulation, and application of electromagnetic standards, measurements, techniques, instruments, and systems. Sessions are tentatively planned to cover the following technical areas: electromagnetic-related fundamental constants and standards; direct current, low frequency, and radiofrequency; time, time interval, and frequency; antennas and fields; microwaves and millimeter waves; infrared, visible, and ultraviolet radiation; lasers; electro-optics and fiber optics; cryoelectronics; automated measurements; and technical calibration services. The Conference language will be English. [Contact: Sara Torrence, (301) 921-2721. (For technical information, contact John R. Sorrells, (301) 921-2727 or Norman B. Belecki, (301) 921-2715.)]

9-10 September (Boulder, CO)

Symposium on Optical Fiber Measurements. This fourth biennial Symposium is devoted to measurements on optical fiber, related components, and systems. It is sponsored by NBS in cooperation with the IEEE Optical Communications Committee and the Optical Society of America and is intended to provide a forum for reporting the results of recent measurements research and for evaluating these results in terms of future directions. About one-quarter of the sessions will be workshops led by invited panelists. Summaries of presented papers will be published in a technical digest to be distributed at the Symposium.
[Contact: Susie A. Rivera, (303) 497-5342]

RECENTLY ISSUED
STANDARD REFERENCE MATERIALS

The first practical superconducting standard reference material (SRM) has been released by the Electromagnetic Technology Division to the NBS Office of Standard Reference Materials for sale to the public. The certified parameter of SRM 1457, Superconducting Critical Current -- NbTi Wire, is critical current at magnetic fields of 2,4,6, and 8 tesla at a temperature of 4.2 K and an electric field criterion of 0.2 μV/cm. Information is given to permit the user to determine critical current for temperatures in the range 3.90 to 4.24 K and electric field criteria from 0.05 to 0.2 μV/cm.

SRM 1457 consists of a 2.2-m length of a multifilimentary, niobium-titanium, copper-stabilized wire, wound in a single layer on a spool having a core diameter of 8.7 cm. The wire is evaluated for 34 parameters relating to current, voltage, magnetic field, temperature, strain, and physical specimen characteristics.

In conjunction with ASTM Standard Test Method B714-82, D-C Critical Current of Composite Superconductors, the new SRM is intended to provide means for calibrating apparatus used to measure key parameters of superconductor products and thus should be useful to buyers and sellers of superconductors, users of superconducting equipment, and researchers in superconducting technology.

CEEE SPONSORS

National Bureau of Standards
Department of Commerce NOAA
Department of Defense
  Defense Advanced Research Project Agency; Combined Army/Navy/Air Force Calibration Coordination Group; Defense Nuclear Agency; National Security Agency
U.S. Air Force
  Bolling Air Force Base; Hanscom Field; Newark Air Force Station; Rome Air Development Center; Space Division; Wright-Patterson Air Force Base
U.S. Army
  Aberdeen Proving Ground; Aviation Research and Development Command; Fort Monmouth; Harry Diamond Laboratories; Fort Belvoir; Redstone Arsenal; Materials and Mechanics Research Center
U.S. Navy
  Aviation Logistics Center (Patuxent River); Naval Air Systems Command; Naval Surface Weapons Center; Naval Weapons Support Center (Crane); Office of Naval Research; Naval Research Laboratory
Department of Energy
  Energy Systems Research; Fusion Energy; Bonneville Power Administration
Department of Justice
  Law Enforcement Assistance Administration
Charles Stark Draper Laboratory
Electronics Industries Association
Food and Drug Administration
Hughes Aircraft Company
International Copper Research Association
International Telecommunications Satellite Organization
Massachusetts Institute of Technology
Sandia National Laboratories
University of California Los Alamos Scientific Laboratory

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NBSIR-86/3366	2. Performing Organ. Report No.	3. Publication Date April 1986

4. TITLE AND SUBTITLE

Center for Electronics and Electrical Engineering Technical Publication Announcements Covering Center Programs, July - September 1985 with 1986 CEEE Events Calendar

5. AUTHOR(S)

E. Jane Walters, compiler

6. PERFORMING ORGANIZATION (If joint or other than NBS, see Instructions)

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

July-September 1985

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

U. S. Department of Commerce
National Bureau of Standards
National Engineering Laboratory
Center for Electronics and Electrical Engineering

10. SUPPLEMENTARY NOTES

All technical information included in this document has been approved for publication previously.

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This is the sixth issue of a quarterly publication providing information on the technical work of the National Bureau of Standards Center for Electronics and Electrical Engineering. This issue of the CEEE Technical Publication Announcements covers the third quarter of calendar year 1985.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

antennas; electrical engineering; electrical power; electromagnetic interference; electronics; instrumentation; laser; magnetics; microwave; optical fibers; semiconductors; superconductors

13. AVAILABILITY

☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☐ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

☒ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

21

15. Price

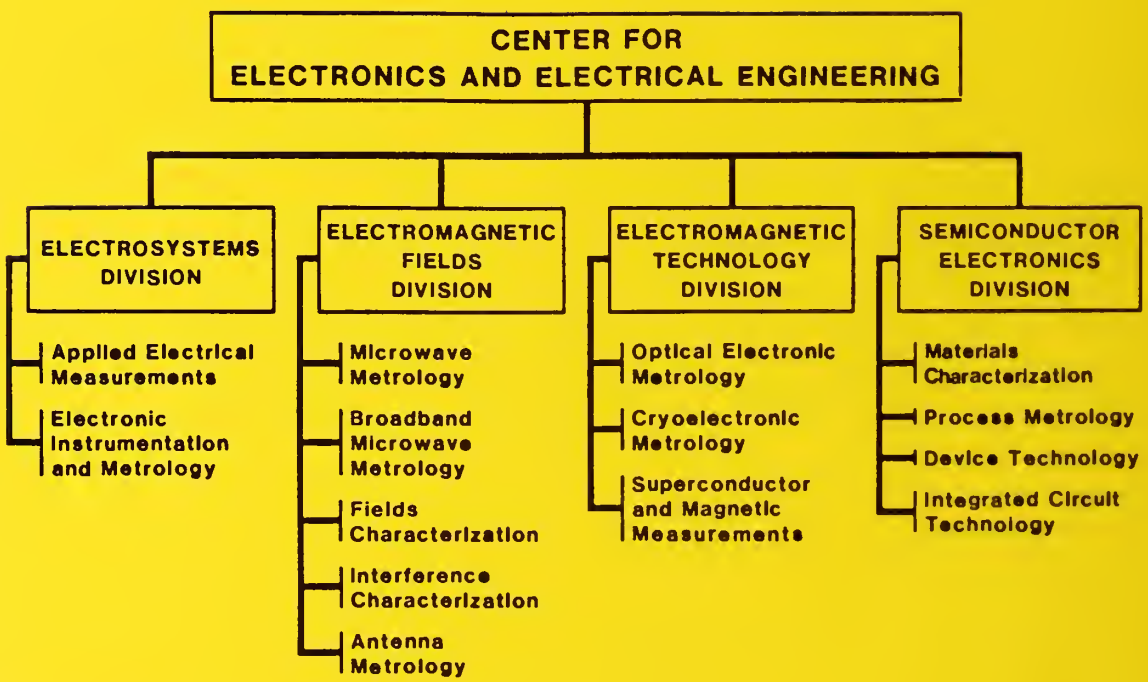
$9.95

USCOMM-DC 6043-P80

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
GAITHERSBURG, MD 20899
RETURN POSTAGE GUARANTEED

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL
POSTAGE & FEES PAID
NBS
PERMIT No. G195



KEY CONTACTS:

Center Headquarters (720)	Director, Mr. Judson C. French (301) 921-3357 Deputy Director, Mr. Robert I. Scace (301) 921-3357
Electrosystems Division (722)	Chief, Dr. Oskars Petersons (301) 921-2328
Electromagnetic Fields Division (723)	Chief, Mr. Charles K.S. Miller (303) 497-3131
Electromagnetic Technology Division (724)	Chief, Dr. Robert A. Kamper (303) 497-3535
Semiconductor Electronics Division (727)	Chief, Dr. Kenneth F. Galloway (301) 921-3541

INFORMATION:

For additional information on the Center for Electronics and Electrical Engineering, write or call:

Center for Electronics and Electrical Engineering
National Bureau of Standards
Metrology Building, Room B-358
Gaithersburg, MD 20899

Telephone (301) 921-3357